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Ability of a land data assimilation system to monitor the water and carbon fluxes of a grassland site in southwestern France

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Global Surface Soil Moisture (SSM) products are now operationally available from active and passive microwave spaceborne instruments. While microwave remote sensing provides a global mapping of the shallow near-surface soil moisture content, combining this information with land surface model simulations through a Land Data Assimilation System (LDAS) allows the retrieval of the root zone soil moisture content (w2). Surface soil moisture permits to improve the representation of w2, which impacts on the partitioning between latent and sensible heat and also runoff and infiltration water. Similarly, the Leaf Area Index (LAI) is a key factor that plays a significant role in the exchange of water vapour and CO2 between the vegetation canopy and the atmosphere.

A Simplified Extended Kalman Filter was used within the SURFEX modelling platform of Météo-France in order to assess the impact on the simulations of the ISBA-A-gs land surface model when assimilating SSM and LAI observations either individually or jointly. This LDAS is tested over a grassland site in southwestern France, the SMOSREX experimental site, for a 7-year period (2001-2007). Contrasting model errors are considered in three configurations: (1) best case simulation with locally observed atmospheric variables and model parameters, and locally observed SSM and LAI used in the assimilation, (2) same as (1) but with the precipitation forcing set to zero, (3) real case simulations with atmospheric variables and parameters of the model derived from regional atmospheric analyses and from soil and vegetation data bases, respectively. In configuration (3), two surface soil moisture time series are considered: local in-situ observations, and a surface soil moisture product derived from L-band radiometer measurement from 15m above the ground.

The ability of the LDAS to monitor the carbon and water fluxes, and the advantage of performing a joint assimilation of both SSM and LAI observations is demonstrated. Some variables like w2, LAI and the surface fluxes present better results when both SSM and LAI are assimilated. In the same way, the robustness of the LDAS when run with degraded atmospheric forcing data is highlighted. A test with zero precipitation and the use of an operational atmospheric analysis (SAFRAN) shows that the joint assimilation of LAI and SSM permits to overcome errors from the forcing. Finally, the added value of a LDAS depends, to a large extent, on the quality of the model. For situations for which the atmospheric variables and the biophysical parameters of the model are well characterised, it is shown that data assimilation has a limited impact on the simulations, as the model performance is already very good. In data poor areas, the assimilation of satellite-derived surface variables is more likely to improve the behaviour of the land surface model.